**Lower Crooked Fuels Treatment Plan**

# A Landscape Analysis of Condition Classes

Technical Fire Management 16

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## ABSTRACT

The Lower Crooked Fuels Treatment Plan is a compilation of information and analysis regarding historic and existing stand condition classes and fire regimes of Plant Association Groups (timbered stands) that are scattered across nearly 22,000 acres of the North Fork Lower Crooked River Watershed and located near the geographic center of Oregon. The purpose of the study is to identify treatment areas and opportunities that return the historic Non-Lethal Very Frequent fire regime to the area. Condition classes, fire behavior and fire effects are modeled and analyzed using a variety of tools including the Geographic Information System (GIS), Viable Ecosystem Guide, FOFEM, FireFamily+ and Fire Management Analyst with an emphasis on the use of Crown Mass. The economic analysis is based on Net Present Value Cost and analyzes the cost of treatments as well as the cost of maintenance treatments well into next century.

EXECUTIVE SUMMARY

The Lower Crooked Project Area is located within the Lower North Fork Crooked River Watershed and contains approximately 22,000 acres of Forest Service lands located in Crook County in Central Oregon. The Ochoco National Forest-Lookout Mountain Ranger District and Paulina Ranger District administer Forest Service lands within this area. Forested Plant Association Groups (PAG's) within the watershed consist of dry grand fir, Douglas-fir, xeric pine, mesic pine, western juniper woodland, and juniper steppe. These forested areas account for nearly 11,400 acres of the watershed. There are large areas of nonforested lands scattered throughout the area. These nonforested areas are mostly sagebrush and grass that surround timbered stands. Forest Service firefighting forces have aggressively suppressed wildfires in the area since the early 1900's. Disturbance has changed from a low intensity, short interval fire regime to a higher intensity, longer interval fire regime. This has contributed to an increase in stand densities and in some stands altered species composition and condition classes in the pine plant association groups. The District Ranger has given direction to reduce understory and canopy densities and move fire regimes towards historic conditions. Historically the dominant fire regime for this area was Non-lethal Very Frequent (NL-VF) with a Historic Range of Variability (HRV) of 57-79% of the watershed. A preliminary study suggests that the existing amount of area supporting a NL-VF regime is 28% of the area. The long-term intent is to return the area to a low intensity, short interval fire regime by restoring the historic amounts of open stands of ponderosa pine and Douglas-fir. This study will identify and evaluate a fuels treatment proposal that could move condition classes to historic amounts in the Lower Crooked Planning Area while maintaining consistency with the Ochoco National Forest Land Management Plan.

**Problem Statement**

The Lookout Mountain District Ranger needs information on methods to restore fuels and stand conditions to historic conditions in a manner that is consistent with the Ochoco National Forest Land Management Plan. Existing condition class amounts are unknown to the decision maker.

**Goals Statement**

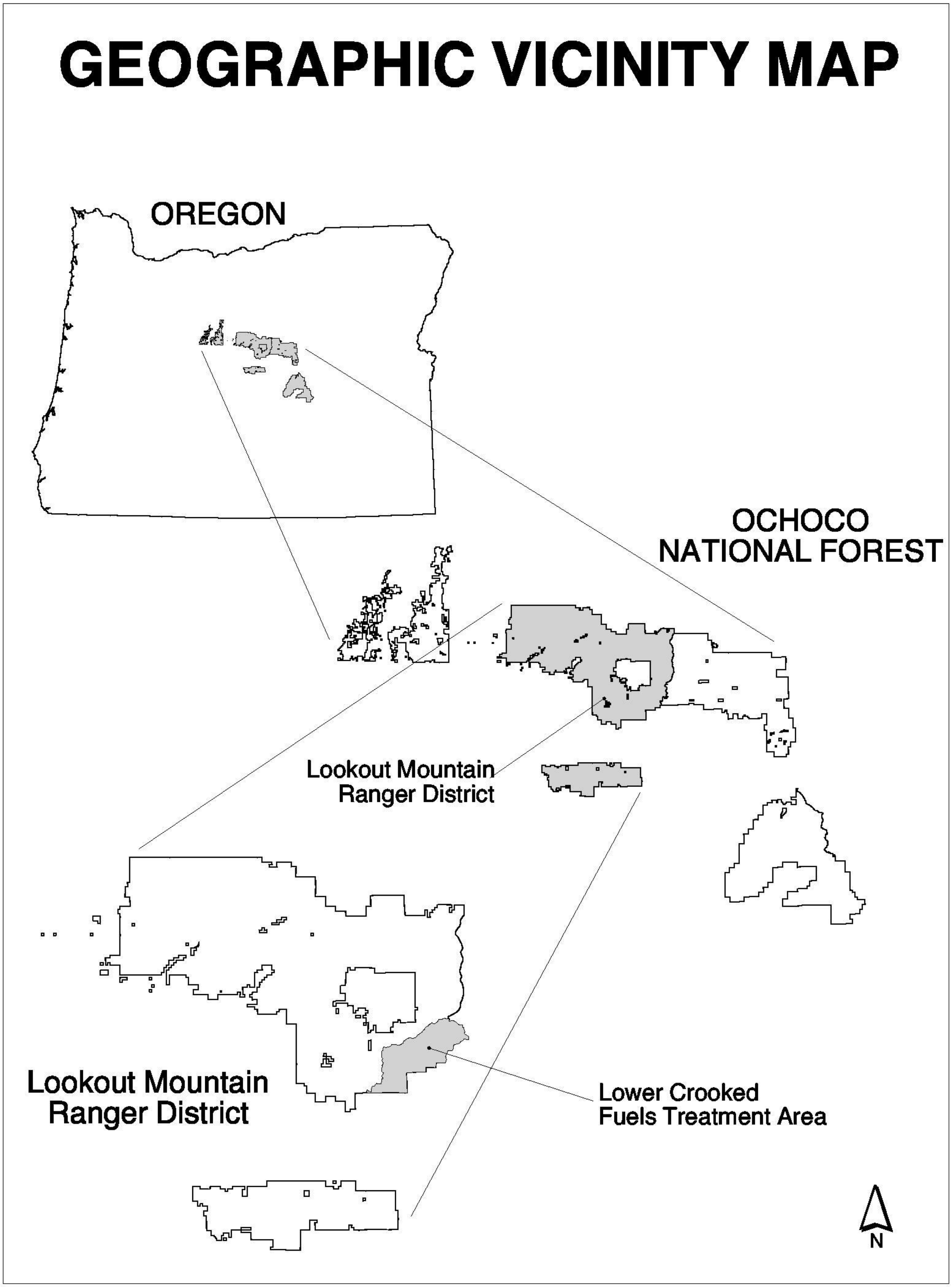
Propose a fuel treatment plan that can be used to reduce stand densities and move condition classes closer to historic amounts in the Lower North Fork Crooked River Watershed as described in the National Fire Plan, A Cohesive Strategy.

**Objectives**

Move forest vegetation and fuels toward historic conditions by increasing the amount of Condition Class 1 to 57-79% of the forested area within the watershed by reducing the amount of <7” dbh trees to <50 per acre, and evaluate treatment alternatives that will restore the area at the least cost.

**Methods**

- Analyze and evaluate existing stand conditions using the Geographic Information System (GIS), satellite imagery, and aerial photos.
- Estimate historic condition class amounts using information from the Viable Ecosystems Management Guide.
- Predict fuel loadings and canopy densities using methods found in the Aids in Determining Fuel Models Handbook and Crown Mass computer program.
- Develop a treatment plan that will display various fuel treatments used to move stands towards historic levels of condition classes.
- Identify resource issues and evaluate treatments by utilizing resource specialists, literature, and existing studies.
- Evaluate treatment plan on an economic basis using a discounting formula to display the Net Present Value.


GEOGRAPHIC VICINITY MAP
OREGON
OCHOCO
NATIONAL FOREST
Lookout Mountain
Ranger District
Lookout Mountain
Ranger District
Lower Crooked
Fuels Treatment Area
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## INTRODUCTION

THE COHESIVE STRATEGY

In an April 1999 report to Congress, the General Accounting Office (GAO) concluded, "the most extensive and serious problem related to the health of the national forests in the interior West is the over-accumulation of vegetation." This report, *Western National Forests: A Cohesive Strategy is needed to Address Catastrophic Wildfire Threats*, criticized the U.S. Forest Service for not having "clear goals, objectives, direction and budgets that adequately address ecosystem restoration and maintenance needs."

In April of 2000 the Forest Service responded with *A Cohesive Strategy for Protecting People and Sustaining Resources in Fire Adapted Ecosystems*. This strategy addresses the hazards and risks from over-accumulations of fuels in NL/VF fire regimes and the wildfires in these regimes, which currently burn at high levels of severity, outside their historic range of variability.

These hazards and risks would be mitigated by applying combinations of prescribed fire and mechanical fuels treatment on 40 million acres of the interior west during the next 15 years, over five times the 7.5 million acres that would have been treated during the same time period at present rates. Most of these acres are in lower elevation forests, which have missed the most fire cycles and departed the most from historic conditions. Forests that historically experienced frequent low-intensity fires are now subject to infrequent high-intensity fires.

By restoring and maintaining healthy fire-adapted ecosystems, the Forest Service would:

- Better ensure public and firefighter safety;
- Reduce wildfire costs, losses, and damages;
- Conserve species and biodiversity; and
- Improve the resilience and sustainability of forests and grasslands at risk

The Cohesive Strategy (page 30) lists the federal laws and regulations used to guide national forest management, including the Endangered Species Act, the Clean Water Act, and the Clean Air Act, which together provide the legal basis for maintaining sustainability of ecosystems.

The Forest Service Government Performance and Results Act (GPRA) Strategic Plan (2000 revision) bridges law and Forest Service activities. The Cohesive Strategy anchors to the following specific objectives from the GPRA Strategic Plan.

- Improve watershed conditions and restore hydrological processes;
- Improve habitat quality; and conserve fish, wildlife and plant populations;
- Improve ecosystem resiliency associated with fire adapted ecosystems; and
- Reduce the risk of damage to human communities associated with wildfires.

## CONDITION CLASSES

In the Cohesive Strategy, forest conditions are divided into three classes by their level of risk. (Risk is defined here as a chance of loss due to high-intensity fire and its effects, such as loss of riparian habitat due to post-fire erosion).

### Condition Class 1

- These are forests with little surface fuel and fewer than 50 trees per acre under 3 inches dbh. Fire cycles function within their historic range of variation. Fires are low intensity underburns; they pose little risk, and have positive long-term effects on biodiversity, soil productivity and water quality. Smoke production is frequent, but low in volume and short in duration. These ecosystems are resistant to disturbance from insects, disease and fire.

Condition Class 2

- These are forests that have missed one or more full fire cycles.  Surface fuel loads are higher than normal, and there are more than 100 trees per acre under 3 inches dbh.  Fires burn at moderate intensities, and conditions are more conducive to vertical fire spread.  More organics are removed from soil and there is more mineral soil exposure, and water quality is at risk from erosion.  Smoke production has increased in volume and duration.  These ecosystems are losing their resilience to disturbance from insects, disease and fire.

Condition Class 3

- These are forests with hundreds of small understory trees per acre, many of which reach into the overstory crown, and the heavy surface fuel loading associated with long-term fire exclusion.  Conditions exist for fires to burn at stand replacement intensities over broad areas.  Soils become hydrophobic and are vulnerable to erosion events.  Smoke production has increased in volume and duration, carrying large amounts of fine particulate matter.  The effects of insects, disease or fire can result in significant damage to, or the complete loss of, defining ecosystem components.

## HISTORIC CONDITION

Historic condition is used as a starting point in defining a viable ecosystem.  Historic condition assumes that the compliment of native species and the vegetative conditions that existed prior to European settlement was viable; that is, the historic ecosystems possessed the above attributes, especially a high level of resilience to the effects of insects, disease, and fire.  The pre-European settlement forest provides the most scientifically sound model because it is based on thousands of years of development, it existed during a period of similar climate, and is more easily documented than forests from any earlier time (Bonnicksen 2000).

Historic condition implies that the character of disturbance agents was different in the past. Historically, fire played the bigger role in influencing forest succession, and the influence of insect and disease agents was short-lived and patchy. But interfering with one disturbance agent (fire) has increased the influence of other disturbance agents (insects and disease)(Gara 2000). These agents now exhibits their influence over entire landscapes in episodes lasting decades, which is a result of replacing open stands of shade-intolerant tree species with dense, closed stands of shade-tolerant species (Agee, 1993).

Historic condition does not imply the absence of human influence, i.e. “natural” forests, in which humans have played no significant role. According to MacCleery (USDA 1999), under that definition there would have been few natural forests, even in 1500 (at the beginning of European occupation). Humans have occupied and influenced America’s forests (by, for example, their frequent application of fire) since the time these forests migrated northward behind the retreating continental glaciers at the end of the last ice age. In the Northwest, one of the common patterns of the Native American use of fire was widespread burning by inland (Columbia Plateau) tribes east of the Cascades (Langston 1995). So, “historic condition” strongly implies a human role in the shape of the landscape. According to Thomas (1993), in the fire-prone ecosystems of the west, Native American burning created an element of ecosystem stability that would not have existed without it. Frequent, low intensity, human-caused fires substantially reduced the amount and range of less frequent, high-intensity, stand replacing fires that otherwise would have occurred. So, historic conditions represent a reasonable point of reference to assess change caused by both nature and humans.

On the Ochoco National Forest, deviations from historic conditions due to the interruption of fire cycles have displaced fire regimes out of their historic range of variability. Because of changes in species composition, stand structure, density and fuel loading, the existing levels of fire severity (low, moderate, stand replacement) are out of their historic proportion to each other. The fire effects that occur as a result of this imbalance, and as a result of management activities, are outside their historic range; fewer acres are burning at low intensities, and more acres are burning (or have the potential to burn) at moderate or high intensities.

## FIRE REGIMES

Fire regimes describe the role fire plays in an ecosystem in terms of frequency and severity. Fire regimes are based on environmental gradients of temperature and moisture, similar to the way plant associations are grouped. The assignment of a specific fire regime to a specific seral/structure stage is a product of fire ecology literature, historical fire records and local fire experience. There are three levels of fire severity, which correspond to the fire behavior and effects described in the three condition classes listed in the Cohesive Strategy:

- Non-lethal (low) severity fires (condition class 1)
- Mixed (moderate) severity fires (condition class 2)
- Stand Replacement (high) severity fires (condition class 3)

**Table 1.** Fire Severities

| Fire Severity | Symbol | Description of Effects on Vegetation |
|---|---|---|
| Nonlethal | NL | More than 70% of the basal area or more than 90% of the canopy cover that existed prior to the fire still remains after the fire. |
| Mixed | M | Fires of intermediate effects, often resulting from a mosaic of varying conditions. |
| Stand Replacement | SR | Less than 20% of the basal area or less than 10% of the canopy cover of the overstory remains after the fire. |

There is a historic fire frequency associated with each level of severity. Frequency is divided into four categories, and each category is associated with a mean fire interval. Mean fire interval is the average number of years between two successive fire events in a given area.

**Table 2.** Fire Frequencies

| Fire Frequency | Symbol | Mean Fire Interval |
|---|---|---|
| Very Frequent | VF | Less than 25 years |
| Frequent | F | 26 - 75 years |
| Infrequent | I | 76 - 150 years |
| Very Infrequent | VI | 151 – 300 years |

VIABLE ECOSYSTEMS

The plant associations for the entire Ochoco National Forest were mapped using 1:16,000 aerial photography and intensive fieldwork. The associations are described in "Plant Associations of the Blue and Ochoco Mountains" (Johnson, 1992). These associations have been combined into plant association groups or PAG's for the purposes of quantifying the biophysical environment of the Ochoco National Forest.

The Ochoco National Forest's Viable Ecosystem Management Guide (VEMG, Version 2.0, unpublished) describes a seral/structural matrix for characterizing forest vegetation within each of the plant association groups. This matrix is a departure from the classic linear succession models, which typically describe succession as a progression through different stages, i.e. early, mid, late, climax. The Ochoco NF matrix has three seral stages based on species composition (early, mid, late), and each of these is subdivided into five size/structural conditions (grass/forb/shrub, seedling/sapling, pole, small trees, large trees). Thus, the matrix can accommodate up to fifteen cells, each represents a different seral (E, M, L) and size/structural (1-5) condition. The grass/forb/shrub condition is only reflected in the early seral condition. An example matrix is shown below:

**Table 3.** Viable Ecosystem Seral/Structural Matrix

| | Early | Mid | Late |
|---|---|---|---|
| Grass/forb/shrub | E1 | N/A | N/A |
| Seed/sapling (1-4.9" dbh) | E2 | M2 | L2 |
| Pole (5-8.9" dbh) | E3 | M3 | L3 |
| Small (9-20.9" dbh) | E4 | M4 | L4 |
| Large (21"+ dbh) | E5 | M5 | L5 |

Note: Matrix cells can be further subdivided to reflect relative differences in tree density. Subscripts "a" and "b" are used to denote high and low density respectively. For example, L4a describes a late-seral species composition, small-sized trees, at a high-density level. The total number of vegetative stages can vary by PAG, ranging from a low of 7 stages up to a high of 20 stages.

The VEMG describes the array of conditions, which may exist within each matrix cell, as well as descriptions of predominant natural processes such as insects/disease and fire. The seral/structural matrix is applied to each PAG for consideration of existing, historic, and desired condition.

Existing conditions were derived from analysis of satellite imagery (ISAT). This imagery displays attributes of ground vegetation, including species composition and size/structure. The VEMG contains a description of how the ISAT data was converted to the VEMG matrix groupings. The resolution of the satellite imagery is 25 x 25 meters, or approximately 1/6th of an acre. Each pixel is assigned to one of the VEMG matrix classifications. Information about known activities that have occurred since the ISAT data was obtained (regeneration harvest and other silvicultural treatments, for example) is used to update the existing condition.

**Problem Statement**

The Lookout Mountain District Ranger needs information on methods to restore fuels and stand conditions to historic conditions in a manner that is consistent with the Ochoco National Forest Land Management Plan. Existing condition class amounts are unknown to the decision maker.

**Goals Statement**

Propose a fuel treatment plan that can be used to reduce stand densities and move condition classes closer to historic amounts in the Lower North Fork Crooked River Watershed as described in the National Fire Plan, A Cohesive Strategy.

HISTORIC RANGES OF VARIABILITY FOR CONDITION CLASSES

For each plant association group (PAG), one of three condition classes was assigned to each seral/structure stage within the viable ecosystems matrix. This determination was made by local expertise and is based on the expected risk of losing key ecosystem components due to fire severity of each seral/structural stage within the PAG. Historic conditions are displayed as a range. See Appendix C, VIABLE ECOSYSTEMS-HISTORIC CONDITION CLASSES.

**Table 4.** Historic Range of Condition Classes by Plant Association Group

| **Plant Association Group** | **Condition Class 1 HRV (Acres)** | **Condition Class 2 HRV (Acres)** | **Condition Class 3 HRV (Acres)** |
|---|---|---|---|
| Dry Grand Fir | 3 - 4 | 0 - 1 | 1 - 2 |
| Douglas-fir | 1633 - 2795 | 157 - 691 | 188 - 848 |
| Mesic Ponderosa Pine | 3669 - 5211 | 53 - 1329 | 53 - 744 |
| Xeric Ponderosa Pine | 995 - 1750 | 55 - 516 | 37 - 405 |
| Juniper Woodlands | 947 - 1056 | 33 - 109 | 0 - 11 |

EXISTING CONDITIONS

**Soils**

The Lower Crooked River Fuels Project Area contains a variety of soils and landtypes. Parent materials are largely Columbia/Picture Gorge basalts. Volcanic ash from Mt. Mazama blanketed the area about 6600 years ago and has been subsequently reworked by water and air. Ash soils occur over 22 percent of the area or approximately 4700 acres. The balance of the watershed is largely residual soil which is clay-loam or clay texture

This area is classic scab stringer country with lithic scabland soils on the plateau uplands. These old basalt flow surfaces are incised with deep steep-sided drainways. Soils on these steep to very steep plateau drainages and lava flow scarps are moderately deep to deep on the northerly aspects and shallow to moderately deep on the southerly aspects. These drainway soils are derived from ash overlying or mixed with colluvium.

The drain areas have served to collect wind and water eroded ash from the scablands which have lithic soils derived from basalt. These are very sensitive areas especially along the interface between scablands and forested stringer drainways. Infiltration in the deep ash soils is rapid to very rapid but very slow on the scablands. These edge areas provide critical buffers that help slow down and dissipate the rapid runoff from the scabs.

### Aquatics

The Lower Crooked River Watershed of the North Fork Crooked River system, includes Donnelly Creek, North Fox Canyon Creek, Fox Canyon Creek, Lame Dog Creek, Rough Canyon Creek, Indian Trail Creek and tributaries of these creeks. These creeks consist of Class I, II, III and IV streams and flow into the North Fork Crooked River.

Long-term sustainability of aquatic species is directly linked to the quality and quantity of water moving through the watershed. Prior to the construction of dams on the Crooked, Deschutes, and Columbia Rivers, there were summer steelhead and spring chinook runs, and all major tributaries had resident fish populations. Since then, populations of summer steelhead and spring chinook no longer have access to the Lower Crooked River system.

Redband trout, *Oncorhynchus mykiss,* is the only salmonid species currently present within the watershed. Columbia spotted frog habitat may also be present in the wet meadows and riparian areas. Surveys have not been completed to verify presence of Columbia spotted frogs.

The primary impacts to aquatic resources are:  historic livestock grazing (worst impacts being prior to 1960) and previous timber harvest practices.  Factors contributing to the less than satisfactory conditions of the stream/riparian areas within the watershed include:

- Reduced beaver activity and associated wetlands within lower gradient reaches
- Removing conifer shade and large wood recruitment to the channel through harvest
- Removing critical conifer shading around the riparian areas and increasing stream temperatures
- Impacts on off-channel seeps and wet areas
- Transportation system - road location, stream crossings, inadequate road drainage
- Transportation system - expansion of the drainage network increasing the efficiency of the drainage to move water, increasing peak flows and frequency of flood events
- Previous locations of roads and skid trails within the riparian areas contributed to loss of riparian habitat and increased sediment inputs; compaction and earth displacement from roads and skid trails increasing exposed soil, soil compaction, bank trampling, mass wasting and general degradation of riparian vegetation

The results of these activities:

- Increased water temperature above that considered ideal for redband trout
- Decreased levels of large woody debris that hold sediment, provides pools, cover for fish and helps maintain water temperature
- Reduced pool frequency by increasing slope and decreasing sinuosity
- Increased width/depth ratio
- Decreased sediment transport capacity
- Channel aggradation
- Unstable streambanks

### Wildlife

Pre-field review indicates the following TES wildlife species that have either been documented or have a moderate to high probability of occurring on the forest:

**Table 5.** TES Wildlife Species

| TES Wildlife Species | Documented or Suspected | Habitat |
|---|---|---|
| Northern Bald Eagle – Federally Threatened | D | Large Structure/near water |
| Canada Lynx – Federally Threatened | S | Large Structure/mixed conifer |
| American Perigrine Falcon – R6 Sensitive | D | Cliffs |
| Bufflehead – R6 Sensitive | D | Large snags/near water |
| Western Sage Grouse – R6 Sensitive | D | Sagebrush |
| Upland Sandpiper – R6 Sensitive | S | Large Meadows |
| Gray Flycatcher – R6 Sensitive | D | Sagebrush |
| Tricolored Blackbird – R6 Sensitive | S | Ponds/Marshes |
| California Wolverine – R6 Sensitive | D | Unroaded/Mixed Conifer |
| Pygmy Rabbit – R6 Sensitive | S | Sagebrush |

There are nearly 3400 acres of big game winter range in the planning area. Thermal cover, forage, and harassment are important factors in big game winter range management. Pine forested ecosystems with greater than 40% canopy closure provide thermal cover for deer and elk on winter range. Approximately 50% of the pine acres on winter range can be designated as thermal cover, even though the stands would be considered in moderate to high susceptibility to insect and disease attack (Forest Plan). Shrubs such as bitterbrush and mountain mahogany are an important source of winter browse for elk and mule deer. Controlling harassment is the third management objective for winter range.

### Forest Vegetation

The Viable Ecosystems model has been used to characterize the existing landscape and provides a means of comparison to historical conditions. The focus of this analysis is on three PAG's; Douglas-fir, Mesic Ponderosa Pine, and Xeric Ponderosa Pine. These three PAG's comprise the bulk of the forested landscape in the Lower Crooked area.

Some of the important departures from historic condition are listed below:

1. The exclusion of fire as a disturbance agent, along with past harvest practices, has fostered changes in species composition. In general, today there is relatively more western juniper and Douglas-fir than what occurred historically.

2. Overall, stands dominated by large trees (size class 5) are deficient on the landscape. Stands of large trees with an open "park-like" nature were abundant historically; today, they are relatively scarce. Multi-story dense stands dominated by large trees are within or above their historic levels of abundance in both Pine PAG's and below in the Doulglas-fir PAG. Fire exclusion and past harvest have been the major causes of change. Many stands, which were once dominated by large trees, have been replaced by stands in which pole sized trees (size class 3) are the dominant feature.

3. Increases in stand densities have created more multi-storied stands than occurred historically. Fire exclusion has allowed the development of shade tolerant understories while at the same time selective harvest and overstory removal have decreased the abundance of large tree overstories.

### Botany

There are no threatened or endangered plant species in the geographical region that includes the Ochoco National Forest. Pre-field review indicates the following sensitive plant species that have either been documented or have a moderate to high probability of occurring in the area:

**Table 6.** Sensitive Plant Species

| Sensitive Plant Species | Documented or Suspected | Habitat |
|---|---|---|
| *Achnathreum hendersonii* [Henderson's needlegrass] | D | Scabland |
| *Achnatherum wallowaenis* [Wallowa needlegrass] | S | Scabland |
| *Calochortus longebarbatus* var. *peckii* [Peck's lily] | D | Riparian/Meadow |
| *Carex interior* [interior sedge] | S | Riparian |
| *Lomatium ochocense* [Ochoco lomatium] | D | Scabland |

### Livestock Management

The Lower Crooked project area encompasses three grazing allotments on Lookout Mountain District of the Ochoco National Forest. These allotments are Big Summit, Fox Canyon, and North Fork. All three allotments have active grazing permits.

Big Summit Allotment is approximately 24,470 acres in size. The allotment is divided into eight pastures in which 400 cow/calf pairs are grazed rotationally from May 16 to September 30. The proposed fuels treatments will cover ~70% of Donnelly and 100 % of New Pastures. Combined, those pastures make up approximately one-half of Big Summit Allotment.

Fox Canyon Allotment is approximately 13,850 acres in size. The allotment is divided into three pastures in which 217 cow/calf pairs are grazed rotationally from May 16 to September 30. The proposed fuels treatments will cover all of Fox Canyon Pasture, which contributes up to one-half of the allotment's acreage.

North Fork Allotment is administered by the Bureau of Land Management (Prineville District). The portion of National Forest lands that are within the North Fork Allotment is approximately 6,187 acres. Approximately 50% of the Forest Service Lands in the allotment are proposed for fuel treatments. The North Fork Allotment is grazed rotationally with ~150 cow/calf pairs for 3 ½ months during the summer. Actual grazing dates vary from year to year.

**Post Settlement Use**

The Lower Crooked River Fuels project area is located on predominantly south facing timbered slopes in the Ochoco Mountains along the North Fork of the Crooked River. The uplands and abundant grasses offered summer grazing for domestic stock including sheep, cattle, and horses. For the past 120 years, stock grazing and related activities resulted in fence lines, stock water developments, meandering cattle trails and designated stock driveways. Stock grazing was most intense between the 1880s and 1915 when stock numbers were at their peak and open range was overused.

Minor amounts of logging occurred in the early 1900s when localized areas were harvested using portable sawmills on site. These activities were generally located on the adjacent private lands. Logging activities significantly increased following WWII. Larger areas and greater amounts of timber on the forest were harvested using tractor-logging systems. Road systems were developed and logs were transported to sawmills and timber companies now located in Prineville. Fire suppression activities continued to improve with staffed fire lookouts, aerial reconnaissance, engine crews, and smoke jumpers. Stock grazing has remained somewhat constant over the past 50 years. Recreational use has steadily increased and is the dominant use within the project area. Activities include hunting, camping, driving, fishing, and the use of all terrain vehicles and snowmobiles.

The Treaty with the Tribes of Middle Oregon, June 25, 1855, reserved certain treaty rights on lands ceded by Indians to the United States and the Ochoco National Forest and Crooked River National Grasslands are within these ceded lands. The Confederated Tribes of the Warm Springs Reservation is a sovereign governmental entity representing contemporary Native American culture having an interest in the preservation and protection of it Treaty rights and cultural heritage both within the boundaries of the Warm Springs Reservation and within the Tribe's ceded and aboriginal use areas. Rights and privileges reserved by the Indians in the Treaty include the right to take fish in streams running through and bordering said reservation, and the privilege of hunting, gathering roots and berries, and pasturing stock on unclaimed lands. The Treaty and the Warm Springs Tribal Code, Chapter 40 – Protection of Archaeological, Historical, and Cultural Resources, Ordinance 68 sets forth the protection, preservation, and encouragement of tribal and Indian history, culture, tradition and heritage necessary to ensure the survival of the Confederated Tribes.

### Fire Regimes

The predominant plant association groups can be characterized as Fire Regime Group 1, low severity fire with a mean fire return interval between 0 and 35 years. Historically, the fires were mostly low severity fires, which maintained the open park-like stands dominated by Ponderosa Pine. Fire exclusion has changed the vegetation and structure. Currently much of the landscape is dominated by dense thickets and storied structures with a significant increase in the Douglas-fir component.

The fire regime groups are an extension of the plant association groups and have been identified for the area.

**Table 7.** Natural Historic Fire Regime Groups

| Fire Regime Group | PAG | Fire Return Interval | Fire Severity |
|---|---|---|---|
| I | Pine Types | 0-35 | Low |
| II | Juniper and Rangeland Types | 0-35 | Stand Replacement |
| III | Dry Grand Fir | 35-100 | Mixed |
| IV | Lodgepole | 35-100 | Stand Replacement |
| V | Moist Grand Fir<br>Subalpine Fir | >200 | Stand Replacement |

DATA COLLECTION

Polygons were developed for the analysis area by combining the plant association groups with canopy closure layers in GIS in order to identify areas with similar characteristics based on silvicultural attributes, fuel profiles, and deviation from historic disturbance cycle. Many polygons were subdivided and re-delineated based on field observations. This was done to identify substantial differences in vegetation and/or ground fuels not recognized in the initial polygon development.

GIS based orthophoto maps were developed with polygon boundaries and established center points (centroids) of each polygon with a latitude and longitude. The center point of each forested polygon was visited and information was recorded regarding stand characteristics. These data collection items included:

- Polygon identification number, surface fuel model (NFFL models 1-13)
- Photo series observations of fuels (photo series number)
- Canopy characteristics (approximate height of live crown base, ht of trees and ocular estimate of ladder fuels)
- Fire regime (by PAG)
- Estimation of condition class
- Treatment type (recommended treatment to move to CC1)
- Predicted Slash loading (approximate tons/acre activity would create)
- Next entry timeline
- Digital photo of representative stand conditions

See Appendix D, DATA COLLECTION ITEMS.

Data collection for this project was underway at the release of The National Fire Plan and A Cohesive Strategy. Initially, local fire ecology, silvicultural and fuels experts developed condition class definitions to be applied to this project. The condition classes were identified by the following attributes:

Condition Class 1

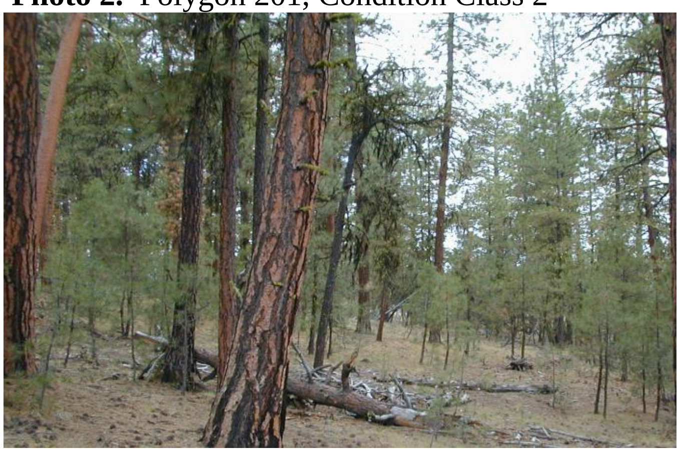
- Maintenance burning as the only treatment is expected to keep stand in good shape.
- 0-1 missed fire cycles
- Conifer understories or Juniper <4 feet tall
- Stand is in a 10 year maintenance burning schedule

**Photo 1.** Polygon 361, Condition Class 1

Condition Class 2

- Narrow window for prescribed fire as only treatment
- Likely a mechanical entry will be needed to return to CC1
- 2-3 missed disturbance cycles

**Photo 2.** Polygon 201, Condition Class 2



Condition Class 3

- Mechanical entry required before any application of prescribed fire, or
- Exotic species infestation prevalent, or
- Severe soil damage due to erosion, compaction or loss of O horizon

**Photo 3**. Polygon 277, Condition Class 3

It was determined by the individuals who developed these condition class definitions that they are aligned with their respective condition classes identified in A Cohesive Strategy. Therefore, for the purposes of this technical paper, the condition class definitions in A Cohesive Strategy will be used.

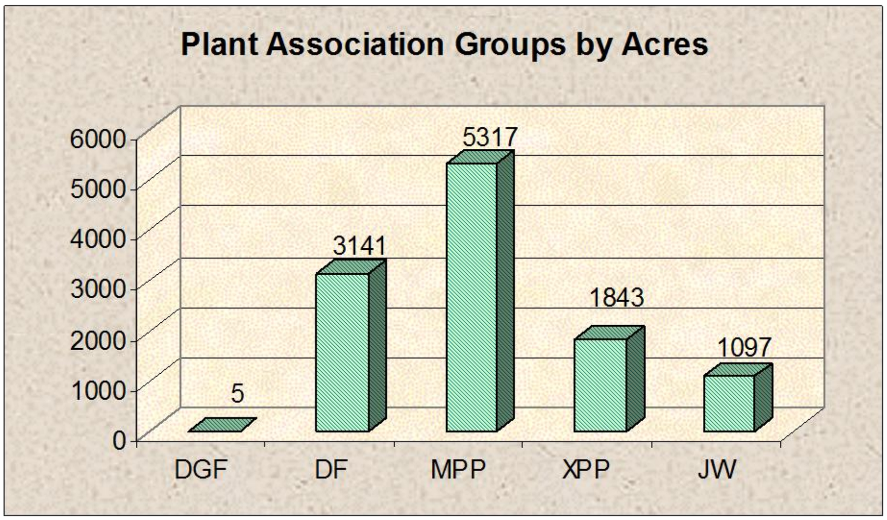
ANALYSIS OF EXISTING CONDITION

Field data was collected, entered into GIS and linked to the appropriate polygons. Information could then be mapped and retrieved through GIS regarding plant association groups, existing condition classes, existing fuel models and recommended treatments among others.

Data tables could then be retrieved, exported and converted to EXCEL SPREADSHEETS where data could be stratified, summarized and graphed. See Appendix E, GIS DATA TABLE.

Graph A displays the representative forested plant association groups by acres for the planning area. The forested portion of the area totals 11,403 acres. Of these forested acres, Dry Grand Fir accounts for 5 acres, Douglas- fir accounts for 3,141 acres, Mesic Ponderosa Pine accounts for 5,317 acres, Xeric Ponderosa Pine accounts for 1,843 acres, and Juniper Woodlands account for 1,097 acres.

**Graph A.** Lower Crooked Plant Association Groups




There are 5 acres of the dry grand fir PAG in the planning area. Fire Regime Group III represents this stand. Even though it is likely a fuels treatment will be applied to the stand in order to move it back to its historic condition class proportions, the scope of this project is to increase the amount of low intensity fire to historic proportions through the reestablishment of condition class 1 where it historically occurred. This stand was historically in mixed fire severity by nature of the PAG. Therefore, The DGF PAG will not be analyzed any further in this paper.

The juniper woodland PAG comprises 1097 acres of the project area. Even though treatments may be applied to this PAG to restore historic amounts of condition classes and to check the encroachment of juniper on the fringes of pine stands, the juniper PAG is recognized as being in Fire Regime Group II, a stand replacement fire severity group. The PAG is currently in historic condition in terms of stand replacement fire severity. For this reason, the Juniper PAG will not be analyzed any further in this paper.

EXISTING CONDITION CLASSES

Polygons were stratified by PAG and by existing condition class, in order to estimate the existing condition class amounts within each PAG. Table 8 displays the results for fire regime group 1.

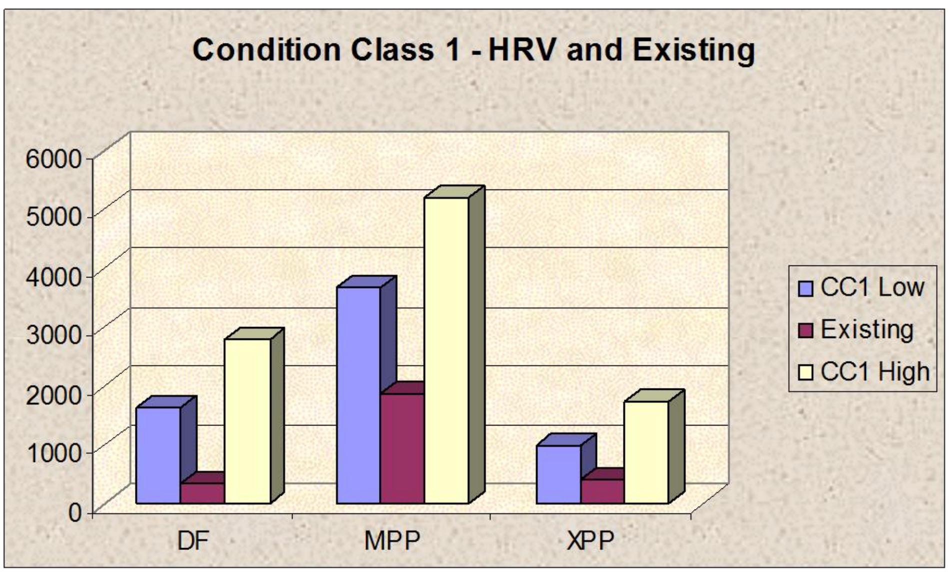
**Table 8.** Existing Condition Classes in Fire Regime Group 1 Plant Association Groups

| Plant Association Group | Condition Class 1 (Acres) | Condition Class 2 (Acres) | Condition Class 3 (Acres) |
|---|---|---|---|
| Douglas-fir | 360 | 2393 | 388 |
| Mesic Ponderosa Pine | 1881 | 3231 | 205 |
| Xeric Ponderosa Pine | 427 | 1401 | 15 |

**COMPARISON OF HISTORIC AND EXISTING CONDITION CLASS DISTRIBUTION**

Graph B displays the historic range of variability (HRV) and the existing amount of condition class 1 (CC1) by plant association group (PAG).

**Graph B.** Historic Range and Existing Amounts of Condition Class 1



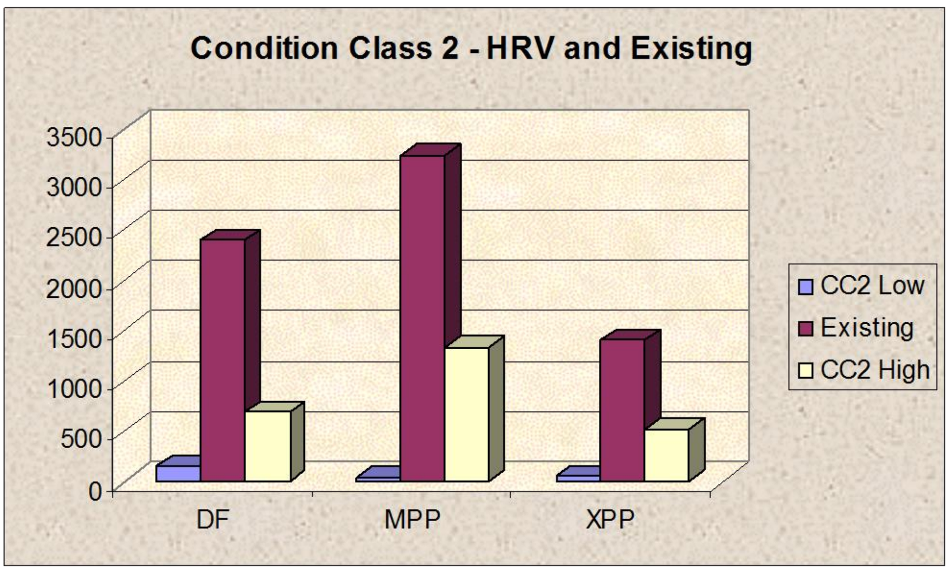

The Douglas-fir (DF) PAG is shown as having a HRV of 1,633 to 2,795 acres with a median of 2,214 acres. The existing acres of CC1 for the DF PAG are 360. This is a deviation of –1,237 acres on the low end, –2,435 acres on the high end of the historic range and –1,854 acres from the median of HRV.

The Mesic Ponderosa Pine (MPP) shows a HRV of 3,669 to 5,211 acres with a median of 4,440 acres. The existing acres of CC1 for the MPP PAG are 1,881. This is a deviation of –1,788 acres on the low end, –330 acres on the high end of the historic range and –2,559 acres from the median of HRV.

The Xeric Ponderosa Pine (XPP) shows a HRV of 995 to 1,750 acres. The existing acres of CC1 for the XPP PAG are 427. This is a deviation of –568 on the low end, –1323 on the high end of the historic range and –946 acres from the median of HRV.

Graph C displays the historic range of variability (HRV) and the existing amount of condition class 2 (CC2) by plant association group (PAG).

**Graph C.** Historic Range and Existing Amounts of Condition Class 2



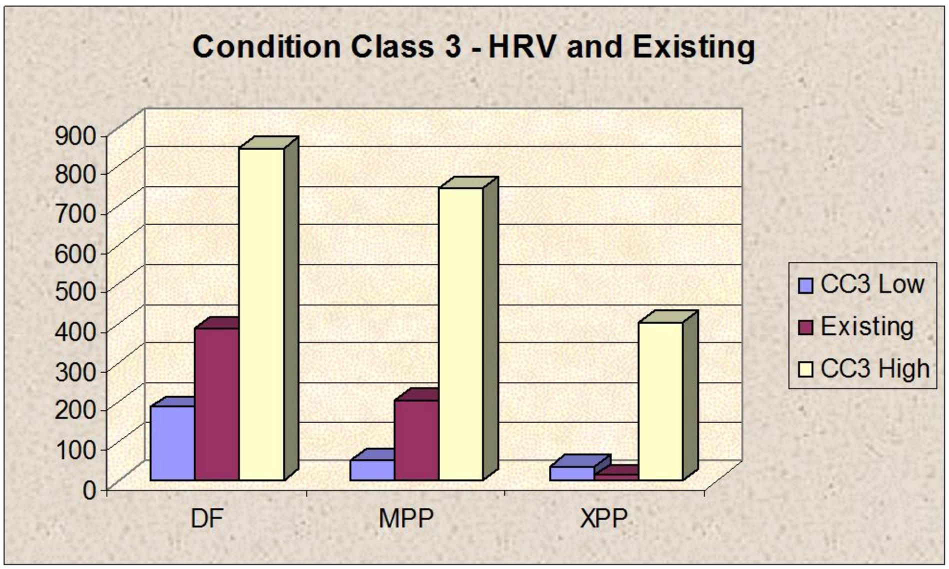

The Douglas-fir (DF) PAG is shown as having a HRV of 157 to 691 acres. The existing acres of CC2 for the DF PAG are 2393. This is a deviation of +2,236 acres on the low end and +1,702 acres on the high end of the historic range.

The Mesic Ponderosa Pine (MPP) shows a HRV of 53 to 1,329 acres. The existing acres of CC2 for the MPP PAG are 3,231. This is a deviation of +3,178 acres on the low end and +1,902 acres on the high end of the historic range.

The Xeric Ponderosa Pine (XPP) shows a HRV of 55 to 516 acres. The existing acres of CC2 for the XPP PAG are 1,401. This is a deviation of +1,346 on the low end and +885 on the high end of the historic range.

Graph D displays the historic range of variability (HRV) and the existing amount of condition class 3 (CC3) by plant association group (PAG).

**Graph D.** Historic Range and Existing Amounts of Condition Class 3




The Douglas-fir (DF) PAG is shown as having a HRV of 188 to 848 acres. The existing acres of CC3 for the DF PAG are 388. This is a deviation of +200 acres on the low end and –460 acres on the high end of the historic range.

The Mesic Ponderosa Pine (MPP) shows a HRV of 53 to 744 acres. The existing acres of CC3 for the MPP PAG are 205. This is a deviation of +152 acres on the low end and –539 acres on the high end of the historic range.

The Xeric Ponderosa Pine (XPP) shows a HRV of 37 to 405 acres. The existing acres of CC3 for the XPP PAG are 15. This is a deviation of –22 on the low end and –390 on the high end of the historic range.

SUMMARY OF EXISTING AND HISTORIC CONDITION CLASSES

**Douglas-fir**

Condition Class 1: below the historic range by 1,273 acres

Condition Class 2: above the historic range by 1,702 acres

Condition Class 3: within the historic range

The Douglas-fir PAG is deficit in CC 1 acres and excess in CC 2 acres. Between 1,702 and 2,236 acres of CC 2 can be returned to CC 1. This would also move all three condition classes to be within HRV.

**Mesic Ponderosa Pine**

Condition Class 1: below the historic range by 1,788 acres

Condition Class 2: above the historic range by 1,902 acres

Condition Class 3: within the historic range

The Mesic Ponderosa Pine PAG is deficit in CC 1 acres and excess in CC 2 acres. Between 1,902 and 3,178 acres of CC 2 can be returned to CC 1 in order for CC 2 to be within HRV. This would also move all three condition classes to be within HRV.

**Xeric Ponderosa Pine**

Condition Class 1: below the historic range by 568 acres

Condition Class 2: above the historic range by 885 acres

Condition Class 3: below the historic range by 22 to 390 acres

The Xeric Ponderosa Pine PAG is deficit in CC 1 acres and excess in CC 2 acres. Between 885 and 1,323 acres of CC 2 can be returned to CC 1 in order for CC 2 to be within HRV. This would also move CC 1 and CC 2 to be within HRV.

The existing amounts of CC 3 are within the historic range of variability for the Douglas-fir and Mesic Ponderosa Pine plant association groups. The Xeric Ponderosa Pine plant association group is deficient in CC 3 by 22 acres. Even though there are CC 3 stands that may have fuels treatments applied in the DF and MPP PAG's that move them into a different Condition class, there will be acres that are maintained as CC 3 to meet historic levels within all of the PAG's. The XPP PAG is 22 acres deficit. Since there isn't a condition class beyond CC 3 in the condition class hierarchy: if historic levels of CC 3 in the XPP PAG are desired, then stands from CC 1 or CC 2 should be managed to move to CC 3. That decision will be made outside of the realm of this paper.

Because condition class 3 is at, or very close to being within the historic range, it will not be analyzed further in this paper.

## DESCRIPTION OF RECOMMENDED TREATMENTS

**Precommercial Thin (PCT)** consists of mechanically cutting trees up to 7" dbh at a predetermined frequency. Precommercial Thinning reduces ladder fuels, thus reducing the potential for crown fires. The desired residual density of trees under 7" dbh varies depending on overall stand density and structure.

**Underburning (UB)** consists of burning natural and activity produced slash located in timbered stands. Slash is ignited under predetermined fuels and weather conditions in order to minimize tree mortality of residual stands. Underburning may occur in as a sole treatment in all condition classes to maintain the current conditions.

**Precommercial Thin and Underburn (PCT-UB)** consists of Precommercial Thinning trees 7" dbh and less. The slash created from the treatment will be lopped on three sides and not be higher that 12 inches off of the ground. The slash will be left to cure and then underburned within 3 to 5 years after thinning is complete. The areas where PCT-UB is the prescribed fuel treatment are typically in Condition Class 2 and have light to moderate patches of understory trees. Post treatment fuel loadings are expected to remain below 12 tons per acre.

**Precommercial Thin with Two Entries (PCTx2)** consists of Precommercial Thinning in two entries. The first entry would thin trees up to 5” dbh. Thinning slash would be lopped on three sides and down to 12” in height and left to decompose for 3 to 5 years before applying prescribed fire. After burning there would be a second entry with PCT to thin the trees between 5” and 7” dbh. The slash created from the second thinning would be treated in the same manner as the first entry. Areas where PCTX2 is the prescribed treatment tend to be in stands that have been identified as being in condition class 2 or 3, have two or more layers of understory and a single entry of PCT would produce too great of a fuel loadings for underburning.

**Underburning and Precommercial Thinning (UB-PCT)** consists of a Natural Fuels Underburning entry followed with Precommercial Thinning. Thinning slash will be lopped on three sides to 12” or less in height. PCT slash will be left to decompose for 3 to 5 years before treating with prescribed fire. These areas tend to be in condition class 2, and have one or two layers of understory. Reducing accumulations of natural fuels prior to PCT is necessary to avoid producing heavy fuel loadings during PCT.

**Pretreat and Underburn (PT-UB)** consists of mechanically adding fuel to the ground by falling trees, lopping slash, and following with prescribed fire. These areas tend to be areas where ground fuels are sparse and junipers have encroached into pine stands. These areas are in condition class 2 where it is unlikely a fire only prescription will accomplish objectives.

**No Treatment (NT)** may have been recommended because of issues concerning wildlife, hydrology, heritage, and botany; or some of these polygons are currently being treated under other environmental assessments.

Field data tables were accessed in GIS and sorted and summed by prescribed treatment. Table 9 displays the prescribed treatments by acres for each plant association group.

**Table 9.** Treatment Type by Plant Association Group

| Rx Treatment | DF Treatment Acres | MPP Treatment Acres | XPP Treatment Acres |
|---|---|---|---|
| No Treatment (NT) | 210 | 707 | 156 |
| Precommercial Thin and Underburn (PCT/UB) | 511 | 683 | 257 |
| Precommercial Thin w/2 Entries (PCTx2) | 130 | 0 | 0 |
| Pretreat and Underburn (PT/UB) | 0 | 93 | 42 |
| Underburn (UB) | 1195 | 2266 | 517 |
| Underburn and Precommercial Thin | 1095 | 1568 | 869 |

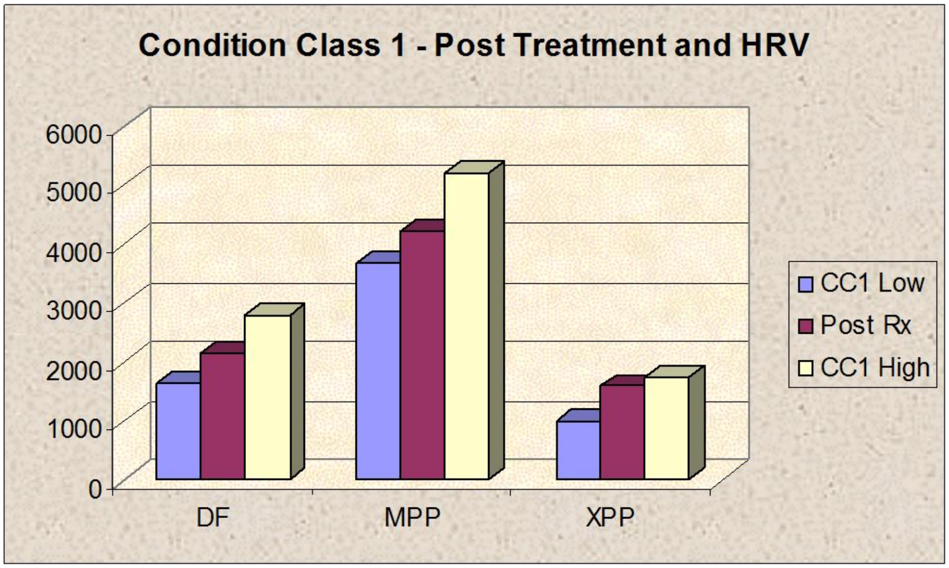
Table 10 displays the total treatment acres for the entire Lower Crooked Planning Area.

**Table 10.** Total Treatment Acres for Planning Area

| Rx Treatment | Total Acres |
|---|---|
| NT | 1207 |
| PCT/UB | 1695 |
| PCTx2 | 130 |
| PT/UB | 808 |
| UB | 3999 |
| UB/PCT | 3563 |

Graph E displays the historic range of variability (HRV) and the predicted post treatment condition class 1 amounts by plant association group (PAG).

**Graph E.** Historic Range and Post Treatment Amounts of Condition Class 1




The Douglas-fir PAG is shown as having a HRV of 1,633 to 2,795 acres. The post treatment acres of CC 1 are 2,150. This is within HRV for the Douglas-fir PAG.

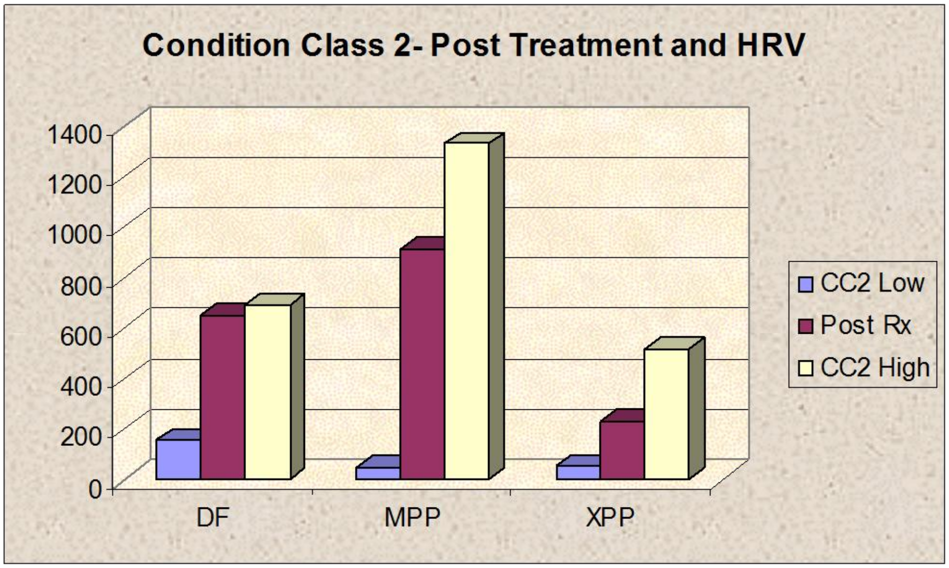
The Mesic Ponderosa PAG is shown as having a HRV of 3,669 to 5,211 acres. The post treatment acres of CC 1 are 4,221. This is within HRV for the Mesic Ponderosa Pine PAG.

The Xeric Ponderosa Pine PAG is shown as having a HRV of 995 to 1,750 acres. The post treatment acres of CC 1 are 1594. This is within HRV for the Xeric Ponderosa Pine PAG.

There will be a total of 7,965 acres of condition class 1 when the proposed treatments are complete. This represents 69.8% of the forested area within the planning area.

Graph F displays the historic range of variability (HRV) and the predicted post treatment condition class 2 amounts by plant association group (PAG).

**Graph F.** Historic Range and Post Treatment Amounts of Condition Class 2




The Douglas-fir PAG is shown as having a HRV of 157 to 691 acres. The post treatment acres of CC 2 are 650. This is within HRV for the Douglas-fir PAG.

The Mesic Ponderosa Pine PAG is shown as having a HRV of 53 to 1,329 acres. The post treatment acres of CC 2 are 915. This is within HRV for the Mesic Ponderosa Pine PAG.

The Xeric Ponderosa Pine PAG is shown as having a HRV of 55 to 516 acres. The post treatment acres of CC 2 are 233. This is within HRV for the Xeric Ponderosa Pine PAG.

See Appendix F, LOWER CROOKED CONDITION CLASS TABLE.

STAND EXAM INFORMATION

For the purpose of modeling fire behavior and fire effects, 30 stand exams were selected from the district archives to represent stands that are presently in condition class 2. The stand exams were performed in 1999 according to Region 6 standards.

Fire behavior runs were made for existing conditions before treatment in fuel model 2 and 9, and conditions during treatment are represented by in fuel model 11BC.

WEATHER ANALYSIS

Historical weather data was collected from the Cold Springs Weather Station (352701) via Kansas City and contains records from 1980 through 2001 (21 years). The station is within 2 air miles from the northern tip of the project area and best represents the area's weather conditions.

Data was entered into FIREFAMILY PLUS and the typical fire season was defined on the Lookout Mountain Ranger District as June 1 – October 15. Modeling was then run for the 90$^{th}$ and 97$^{th}$ percentile day weather observations. Table 11 expresses percentile weather output from FIREFAMILY PLUS labeled as fire behavior condition and is included in Appendix B.

**Table 11.** Fire Weather for Cold Springs Station 352701.

| **Attribute** | **90$^{th}$ Percentile** | **97$^{th}$ Percentile** |
|---|---|---|
| 1 hour | 2.5 % | 2.0 % |
| 10 hour | 3.7 % | 3.1 % |
| 100 hour | 8.3 % | 7.5 % |
| Live Herb. Moisture | 44.9 % | 39.2 % |
| Live Wood Moisture | 75.9 % | 74.1 % |
| 20' Wind | 6.2 MPH | 6.0 MPH |
| Mid-flame Wind | 1.9 MPH | 1.8 MPH |
| Low RH | 11 % | 8 % |
| High Temp. | 87$^{o}$ | 90$^{o}$ |

Given the understanding of these existing conditions, it is possible to interpret fire behavior and subsequent fire effects within the project area.

## FIRE BEHAVIOR MODELING

Fuel Models had to be selected from the 13 Fire Behavior Prediction System (FBPS) models that are organized into four groups: grass, shrub, timber, and slash. They are further described by total fuel load <3-inch, dead fuel load ¼-inch, live fuel load of foliage and fuel bed depth (Anderson 1982).

The process of modeling a fire within the project area began with the selection of FBPS Fuel Models 2 and 9 to model surface fire and crown fire. The basis for these selections was that they were the predominant fuel models encountered during the data collection phase.

To best display the existing condition, for each represented fuel model, given the seasonal fire behavior condition weather displayed above, modeling runs were made with the $90^{th}$ and $97^{th}$ percentile weather conditions as input in CROWN MASS for representation of condition class 2 stands.

Fuels Management Analyst programs apply the Rothermel model, a surface fire spread model, and Van Wagner's crown fire model, a model that estimates crown fire thresholds and rates of spread.

Table's 12 and 13 display outputs from CROWN MASS 1.1.69 in FUELS MANAGEMENT ANALYST and is included in Appendix G.

## EXISTING FIRE BEHAVIOR

Stand modeling was accomplished by randomly selecting 30 Forest Vegetation Simulator (FVS) tree lists, using a random number computer program; from stand exams performed in condition class 2 stands within the project area. The FVS tree lists were input in CROWN MASS for modeling of condition class 2 stand characteristics. The species composition of the tree lists sampled is a mix of ponderosa pine and Douglas-fir with a few western juniper.

**Table 12.** Output from CROWN MASS for Condition Class 2

| Fuel Model | Percentile Weather | Rate of Spread | Flame Length | Critical Flame Length | Fireline Intensity (btu/ft/sec) | Critical Fireline Intensity | Crown ROS | Crown Fraction Burned |
|---|---|---|---|---|---|---|---|---|
| 2 | $90^{th}$ | 13.5 | 4.4 | 4.0 | 143 | 115.2 | 14.2 | .14 |
| | $97^{th}$ | 13.8 | 4.6 | 4.0 | 154 | 115.2 | 14.6 | .18 |
| 9 | $90^{th}$ | 3.6 | 2.2 | 4.0 | 31 | 115.2 | 0 | 0 |
| | $97^{th}$ | 3.6 | 2.2 | 4.0 | 32 | 115.2 | 0 | 0 |

Output from CROWN MASS regarding existing crown fuels characteristics reports that the canopy base height for the represented stands is 7 feet and the canopy bulk density is .0101 lbs/ft3. Fire behavior prior to a fuels treatment is displayed by the outputs of CROWN MASS. In fuel model 2 critical flame lengths are exceeded and passive crown fire is initiated, likely as singletree or group torching. Mortality from scorch is stand replacement for all species <5" dbh. In general, fire tolerant species such as ponderosa pine in the 14" dbh range have 75% chance of survival for fire effects predictions in 90th percentile weather conditions. For local forest managers this is below acceptable levels.

The First Order Fire Effects Model (FOFEM) shows that ponderosa pine in the 16' dbh range have Probability of Mortality of .1 when exposed the predicted flame lengths of fuel model 2. This implies that if ponderosa pine stands located in fuel model 2 are managed to favor trees 16" dbh and greater, the stands ability to withstand adverse fire effects will increase. See Appendix H, FOFEM

Fuel Model 9 fire behavior exhibits flame lengths below the critical flame length level, therefore the fire is unlikely to transition into a crown fire. The survival rate for the same 14" dbh ponderosa pine in this fuel model is 89%, a tolerable probability for local managers.

FIRE BEHAVIOR AND STAND CHARACTERISTICS AFTER TREATMENT

A simulated thinning treatment was modeled with the CROWM MASS program by removing all species at or below 5" dbh. Activity created slash was then modeled with CROWN MASS. FUELS MANAGEMENT ANALYST (FMA) contains a Master Fuel Model Set. The FMA master fuel model set contains 109 derivative FBPS fuel models. These include 37 fuel models to represent grass, brush and timber litter and 72 to represent slash. For each FBPS slash fuel model, a graduation of fuel models is available with total fuel loading increments of 2-3 tons per acre, each having 3 fuelbed depths. Surface fuel models 2 and 9 were combined with fuels from crowns, boles, and tops. The program option for "suggested fuel models" was selected. Activity slash in surface fuel model 2 is modeled as Fuel model 11CC. Activity slash in surface fuel model 9 is modeled as Fuel Model 11CB. Fire behavior for untreated thinning slash in the different weather conditions are displayed below.

**Table 13.** Output from CROWN MASS for Condition Class 2 Thinning Slash

| Fuel Model | Percentile Weather | Rate of Spread (ch/hr) | Flame Length (ft) | Critical Flame Length | Fireline Intensity (btu/ft/sec) | Critical Fireline Intensity | Crown Rate of Spread | Crown Fraction Burned |
|---|---|---|---|---|---|---|---|---|
| 11CC | $90^{th}$ | 2.6 | 2.0 | 8.8 | 26 | 642 | 0 | 0 |
| 11CC | $97^{th}$ | 2.8 | 2.1 | 8.8 | 29 | 642 | 0 | 0 |
| 11CB | $90^{th}$ | 1.9 | 1.7 | 8.8 | 17 | 642 | 0 | 0 |
| 11CB | $97^{th}$ | 1.9 | 1.7 | 8.8 | 19 | 642 | 0 | 0 |

Output from CROWN MASS regarding crown fuels characteristics within the treated stands reports that the canopy base height has risen to 22 feet and the canopy bulk density is lower at .0062 lbs/ft3. Fire behavior predictions show that the critical flame length, the minimum flame length need to initiate crown fire, has risen to 8.8 feet. This is due to the increase in the canopy base height. Since canopy base height is a factor for crown fire initiation, the probability of crown fire occurring in treated stands has decreased throughout the entire range fuel models and of weather conditions that exist in the project area. This is especially true for stands in Fuel Model 2 where existing critical flame lengths in untreated stands are presently exceeded. See Appendix G, CROWN MASS FIRE BEHAVIOR SUMMARIES.

*Assumptions:*

1) A .3 wind reduction factor was used to model partially sheltered fuels (Rothermel, 1983).
2) Weather analysis was performed for dates June 1 – October 15, that defines the fire season on the Lookout Mountain Ranger District.
3) Variable required weather input for CROWN MASS was determined by requesting frequency distribution reports from Firefamily Plus. This best described the "worst case" scenario.
4) The fire model describes fire behavior at the flaming front.
5) Primary carrier of the fire is the dead fuel less than one-quarter inch in diameter.
6) The fire model is primarily intended to describe fires advancing steadily, from a point, independent of the source of ignition.
7) The fire model describes fire spreading through surface fuels and the crowns .
8) Fuel, moisture, wind and slope are assumed to be constant during the time that the predictions are to be applied (Andrews, 1986).

## RISK ASSESSMENT

"In many of the interior West forests, the cost and the risks of inaction are greater than the costs and risks of remedial action." *Concluding comments from academic and agency scientists. Assessing Forest Ecosystem Health in the Inland West Workshop (November, 1993)*

Potential fire behavior in the existing understory structure and composition is a threat to values at risk and the overstory ponderosa pine. In the Douglas-fir plant association, Douglas-fir will continue to gain prominence over time in stands that historically developed with high frequency/low intensity fires that helped reduce the shade tolerant Douglas-fir. This same fire encouraged the shade intolerant, fire adapted ponderosa pine by providing a mineral seed bed for regeneration, open growing space and reduced competition from other trees. Succession without fire is moving the stands towards a dominant climax species under and mid-story.

Data retrieved from the FIRE OCCURANCE ZONE (FOZ) layer in GIS indicates that there is a .106 probability per 1000 acres, of a fire occurring. The project area is 21,605 acres, .106 * 21.6 = 2.29. Therefore, the mean fire occurrence is 2.3 fires per year within the planning area.

The risks associated with no treatments:

- Risk of undesired fire effects
- Risk of increased suppression costs
- Risk of injury to firefighters

Undesired fire effects associated with not treating the current fuels condition include tree mortality, sensitive plant mortality, soil exposure, potential exotic weed infestation, riparian habitat degradation, increased stream temperatures, increased run-off, sediment delivery to streams, aquatic mortality, loss of cultural and heritage resources, and loss of wildlife habitat.

Suppression costs and wildfire acres burned (1980 to 1999), although more episodic during a period of drought, have increased due to over-accumulation of fuels and a corresponding increase in high-risk acreage. Recently, large fires have become more damaging and more costly. Unless the rate of restoration is increased, larger burned acreages and higher wildfire suppression costs should be expected (A Cohesive Strategy, 2000).

Table 14 contains estimates of fire behavior and fire sizes. Fire behavior runs were made using FIRE MANAGEMENT ANALYST. Fire perimeters were estimated using the FIRELINE HANDBOOK perimeter chart (Appendix A, Pg. A-33) (Jan. 98).

**Table 14.** Rates of Spread, Flame Lengths and Fire Size for Fuel Model 2 and 9.

| Fuel Model | Weather Percentile | Rate of Spread (ch/hr) | Flame Length (ft) | Fire Size 1st Hour (acres) | Fire Perimeter (chains) |
|---|---|---|---|---|---|
| 2 | 90th | 13.5 | 4.4 | 12.5 | 59 |
| | 97th | 28.5 | 6.4 | 13.5 | 61 |
| 9 | 90th | 5.3 | 2.6 | 1 | 17 |
| | 97th | 6.7 | 3.0 | 1 | 17 |

Fires occurring in the 90th and 97th percentile weather conditions in fuel model 2 are shown having intensities to great for direct attack. It is likely that fires of this intensity will require mechanized equipment for fireline construction and Air support (retardant and air attack) during initial attack.

A recent study, *Wildland Firefighter Entrapments* (Munson 2000), found that 43 percent of the firefighting fatalities occurred during type IV or V fires. Twenty-nine percent of the fatalities occurred during type III fires. These three fire types accounted for 72 percent of all wildland fire fatalities from 1976 to 1999 (Driessen, 2002).

There have been numerous publications, studies and discussions regarding over-accumulation of forest fuels. It has been scientifically demonstrated (perhaps thousands of times each summer) that landscapes which have had appropriate fuels treatments applied are less likely to produce fires that exceed initial attack efforts. Table 15 contains Production rates of common firefighting resources for the Lookout Mountain Ranger District. Referenced from the FIRELINE HANDBOOK (Jan. 98).

**Table 15.** Production Rates of Firefighting Resources Common to LMRD.

| **Firefighting Resource** | **Fuel Model** | **Specific Condition** | **Production CH/HR** |
|---|---|---|---|
| Engine Crew (3 person) Initial Action Rates | 2 | All | 15 |
| Scratch line rates | 9 | Conifers | 12 |
| | 11 | All | 12 |
| 20 Person Crew (Type II) Sustained Rates | 2 | All | 16 |
| Fireline construction, holding and burn-out rates | 9 | Conifers | 16 |
| | 11 | All | 9 |
| Dozer (Type III) Single Pass | 2 | Slope Class 1 | Up 55-90<br>Down 90-110 |
| | 9 | ,, | Up 35-55<br>Down 55-60 |
| | 11 | ,, | Up 15-25<br>Down 25-30 |

Table 16 contains 2001 average fire cost information by size class for the Ochoco National Forest. Figures are displayed for suppression costs and net value change and for suppression costs only.

**Table 16.** 2001 NFMAS Average Fire Costs (Per Acre) for the Ochoco National Forest

| **Fire Class** | **Size (Acres)** | **Suppression Cost + NVC (Per Acre)** | **Suppression Costs (Per Acre)** |
|---|---|---|---|
| A | 0.0 – 0.25 | $7,112 | $2,032 |
| B | 0.26 – 9.9 | $4,436 | $3,560 |
| C | 10.0 – 99.9 | $3,315 | $3,018 |
| D | 100.0 – 299.9 | $2,113 | $2,000 |
| E | 300.0 – 999.9 | $2,307 | $2,307 |
| F | 1000.0 – 4999.9 | $892 | $892 |
| G | 5000 + | $309 | $309 |

## RISK AND MITIGATION

The risks associated with prescribed fire treatments:

- Risk of undesired fire effects
- Risk of fire escape

Mitigations for the risk of undesired fire effects:

- Identify appropriate stand conditions
- Define the appropriate fire prescription

Mitigations for the risk of fire escape:

- Identify appropriate firebreaks
- Identify appropriate contingency resources

COST ANALYSIS

The discounting formula was selected for analyzing treatment costs. Future treatment costs are expected. This formula displays the present value. Treatment costs were determined from costs associated with similar treatments on 3 Ranger Districts located on 3 different National Forests in the central Oregon area. Table 17 displays current treatment cost per acre for the project area.

**Table 17.** 2002 Treatment Costs for Service Contract and Force Account Workforces

| Activity | Service Contract Cost/Acre | Force Account Cost/Acre |
|---|---|---|
| Underburning | 98.00 | 60.00 |
| Precommercial Thinning | 90.00 | 60.00 |
| Pre-Treatment | 50.00 | 35.00 |

*Discounting Formula*

$$V_o = \frac{V_n \left\{1 - (1+i)^{-n}\right\}}{(1+i)^t - 1}$$

$V_0$ = present value (time is now = 0)

$V_n$ = future value (value in year $n$)

$i$ = discount rate (annual)

$n = t$ * number of treatments

$t$ = treatment interval (frequency)

Typically a discount rate of 4% is used by the Forest Service, consistent with the NFMA act of 1976 (Rideout 1997).

**<u>Alternative 2</u>** Treatments would be completed with Force Account workforces.

**Precommercial Thinning – 5518 Acres**

Precommercial thinning will occur at a rate of 1 treatment of 920 acres per year for the next 6 years. The future value of each treatment is $55,200.00.

$$V_o = \frac{V_n\{1-(1+i)^{-n}\}}{(1+i)^t-1} = \frac{\$55,200.\{1-(1.04)^{-6}\}}{(1.04)^1-1} = \frac{\$11,574.64}{.04} = \$289,366.$$

The future value of $82,800.00 per year for the next 6 years, discounted at a rate of 4% produces a Net Present Value (NPV) of $289,366.00.

**Fuels Pretreating – 808 Acres**

Pretreatment of fuels will occur at a rate of 1 treatment of 202 acres per year for the next 4 years. The future value of each treatment is $7,070.00

$$V_O = \frac{V_n\{1-(1+i)^{-n}\}}{(1+i)^t-1} = \frac{\$7,070.\{1-(1.04)^{-4}\}}{(1.04)^1-1} = \frac{\$1,026.53}{.04} = \$25,663.$$

The future value of $10,100.00 per year for the next 4 years, discounted at a rate of 4% produces a NPV of $25,633.00.

**Underburning – 13,888 Acres**

Underburning will occur at the rate of 1 treatment of 1,390 acres per year for the next 10 years. The future value of each treatment is $83,400.00.

$$V_o = \frac{V_n\{1-(1+i)^{-n}\}}{(1+i)^t-1} = \frac{\$83,400.\{1-(1.04)^{-10}\}}{(1.04)^1-1} = \frac{\$27,057.95}{.04} = \$676,449.$$

The future value of $83,400.00 per year for the next 10 years, discounted at a rate of 4% produces a NPV of $676,449.00.

**Maintenance Underburning**

Maintenance Underburning begins after the initial 10-year treatment period. The entire project area will be in a 12-year rotation. Maintenance Underburning will occur at the rate of 1 treatment of 3,100 acres every 4 years for the next 120 years. The future value of each treatment is $186,000.00.

$$V_o = \frac{V_n\left\{1-(1+i)^{-n}\right\}}{(1+i)^t - 1}(1+i)^{-d} = \frac{\$186,000.\left\{1-(1.04)^{-120}\right\}}{(1.04)^4 - 1}(1.04)^{-6} = \frac{\$184,319.21}{.17} * 1.007 = \$1,091,820.$$

The future value of $186,000.00 every 4 years for the next 120 years beginning in 10 years, discounted at a rate of 4% produces a NPV of $1,091,820.00

**Total NPV of Alternative 2 Fuel Treatments**: $991,478.00.

**Total NPV of Alternative 2 Maintenance Underburning**: $1,091,851.00

**Alternative 3** Treatments would be completed utilizing Service Agreements.

**Precommercial Thinning – 5518 Acres**

Precommercial thinning will occur at a rate of 1 treatment of 920 acres per year for the next 6 years. The future value of each treatment is $82,800.00.

$$V_o = \frac{V_n\left\{1-(1+i)^{-n}\right\}}{(1+i)^t - 1} = \frac{\$82,800.\left\{1-(1.04)^{-6}\right\}}{(1.04)^1 - 1} = \frac{\$17,361.96}{.04} = \$434,049.00$$

The future value of $82,800.00 per year for the next 6 years, discounted at a rate of 4% produces a Net Present Value (NPV) of $434,049.00.

**Fuels Pretreating – 808 Acres**

Pretreatment of fuels will occur at a rate of 1 treatment of 202 acres per year for the next 4 years. The future value of each treatment is $10.100.00.

$$V_O = \frac{V_n\left\{1-(1+i)^{-n}\right\}}{(1+i)^t - 1} = \frac{\$10,100.\left\{1-(1.04)^{-4}\right\}}{(1.04)^1 - 1} = \frac{\$1,466.48}{.04} = \$36,662.00$$

The future value of $10,100.00 per year for the next 4 years, discounted at a rate of 4% produces a NPV of $36,662.00.

**Underburning – 13,888 Acres**

Underburning will occur at the rate of 1 treatment of 1,390 acres per year for the next 10 years. The future value of each treatment is $136,220.00.

$$V_o = \frac{V_n\left\{1-(1+i)^{-n}\right\}}{(1+i)^t - 1} = \frac{\$136{,}220.\left\{1-(1.04)^{-10}\right\}}{(1.04)^1 - 1} = \frac{\$44{,}194.65}{.04} = \$1{,}104{,}866.00$$

The future value of $136,220.00 per year for the next 10 years, discounted at a rate of 4% produces a NPV of $1,104,866.00.

**Maintenance Underburning**

Maintenance Underburning begins after the initial 10-year treatment period. The entire project area will be in a 12-year rotation. Maintenance Underburning will occur at the rate of 1 treatment of 3,100 acres every 4 years for the next 120 years. The future value for each treatment is $303,800.00.

$$V_o = \frac{V_n\left\{1-(1+i)^{-n}\right\}}{(1+i)^t - 1}(1+i)^{-d} = \frac{\$303{,}800.\left\{1-(1.04)^{-120}\right\}}{(1.04)^4 - 1}(1.04)^{-6} = \frac{\$301{,}054.72}{.17} * 1.007 = \$1{,}783{,}306.00$$

The future value of $303,800.00 every 4 years for the next 120 years beginning in 10 years, discounted at a rate of 4% produces a NPV of $1,783,306.00.

**Total NPV of Alternative 3 Fuel Treatments**: $1,575,577.00

**Total NPV of Alternative 3 Maintenance Underburning**: $1,783,306.00

## ALTERNATIVES

Alternative 1

No Action. No management activities would occur other than fire suppression. Forest succession would continue as more acres transitioned toward condition class 3. Douglas-fir will continue to gain a greater prominence over time in stands that historically developed with high frequency/low intensity fires that helped reduce the shade tolerant fir. Accumulation of ground fuels will continue and produce fires of greater intensities with higher rates of spread.

Alternative 2

Preferred Alternative. This alternative raises the average crown height by ladder fuel reduction treatments utilizing precommercial thinning, fuels pretreatment (lop), prescribed underburning and prescribed maintenance burning. This alternative would limit unplanned ignitions in the treatment areas to surface fire, mitigating the risk to residual ponderosa pine overstories. Additionally, precommercial thinning would help promote ponderosa pine regeneration by providing more open space by reducing competition and allowing more sunlight to reach the forest floor. Under this alternative the cost analysis focused on implementing treatments with a Force Account Workforce.

Alternative 3

Alternative 3 treatment prescriptions and effects are identical to those in alternative 2. Under Alternative 3 treatments will be implemented using contracted work forces working under service agreements.

Table 18 below displays the Net Present Value of treatments when implemented by a Force Account Workforce (alt.2) and a Service Contract (alt.3).

**Table 18.** Net Present Value of treatments by alternative

| **Treatment Type** | **Force Account Implementation Costs Alt.2** | **Service Contract Implementation Costs Alt.3** |
|---|---|---|
| Precommercial Thinning | $289,366.00 | $434,049.00 |
| Fuels Pretreating | $25,663.00 | $36,662.00 |
| Underburning | $676,449.00 | $1,104,866.00 |
| Maintenance Underburning | $1,091,851.00 | $1,783,306.00 |
| **Total Treatment Cost** | $2,083,329.00 | $3,358,883.00 |

## RECOMMENDATIONS AND RATIONALE

The recommended alternative is Alternative 2 and is selected purely on economic efficiency. Both alternatives 2 and 3 return condition classes within the historic range of variability, and in the event of unplanned ignitions overstory mortality will remain at acceptable levels. The scheduled prescribed maintenance burning would further promote ponderosa pine by exposing bare mineral soil for natural seedling germination. With thinning and prescribed fire maintenance burning, ponderosa pine would become a more dominant component of the stands, perpetuating the stands ability to survive an unplanned ignition in the future.

## CONCLUSION

The Lower Crooked project area was analyzed to determine the existing situation of the fire Condition Classes, and make a comparison to what existed historically.  The analysis focused on the three predominant plant association groups (Douglas-fir, mesic ponderosa pine, and xeric ponderosa pine).  These three groups account for approximately 90 percent of the forested acres in the area.

Currently the amount of Condition Class 1 is below historic levels in all three PAGs, while Condition Class 2 is well above.  The amount of Condition Class 3 is within or very close to the historic ranges for this condition.  This is the direct result of fire exclusion and other management practices which have occurred over the past 90 years.  The area has lost much of it's resiliency and is now at risk of experiencing disturbances such as wildfire that would be of an intensity rarely, if ever, experienced in the past.

A plan has been developed which is intended to move the landscape back towards its historic condition.  Several treatment methods have been recommended which are intended to return the area into a condition where fire can once again function as an acceptable disturbance process.  These treatments focus on the reduction of existing surface fuels and the removal of excessive understories.  This proposal includes 10,195 acres of treatment ranging from maintenance underburning to multiple precommercial thinning/burning entries.  These treatments were scheduled over the next 10 years and the present net value (or cost) of the treatments range from approximately $2.1 million to $3.4 million.

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